

REMARKS

Claims 1-23 are pending in this Application. Applicants respectfully request reconsideration in light of the following remarks. Applicants submit that these remarks fully address the issues raised in the Final Office Action.

Rejections Under 35 U.S.C § 102

Claims 1-2, 6-18, 16-19, 21 and 22 are rejected under 35 U.S.C 102(e) as being anticipated by U.S. Patent No. 6,274,008 to Gopalraja et al. ("Gopalraja"). Claims 1-2, 6-18, 16-17, 21 and 22 are rejected under 35 U.S.C 102(e) as being anticipated by U.S. Patent No. 6,287,977 to Hashim et al. ("Hashim").

Claim 1 relates to a method for depositing a diffusion barrier and metal conductive layer involving depositing first and second portions of a diffusion barrier, and then depositing a metal conductive layer. The claim recites depositing a barrier layer having two portions: the first portion of a barrier layer deposited on sidewalls simultaneously while the bottom of the via is etched, and (b) a second portion of a diffusion barrier, which covers at least the bottoms of the recessed features.

In the previous Amendment, Applicants amended the claims to specify that depositing the first portion of the barrier layer in (a) comprises sputtering metal from a source. The Examiner states in the current Office Action that "the deposition of the diffusion barrier appears to result from metal sputtering process from a target."

Applicants submit that while there is a TiN or TaN diffusion barrier deposited by sputtering a metal source, neither reference shows (a) depositing a first portion of diffusion barrier by sputtering metal from a target while simultaneously and (b) depositing a second portion of the diffusion barrier.

First, with regard to Hashim, the Examiner cites the embodiments pictured in Figs. 1-10, with emphasis on Figs 4A-D. Specifically, the Examiner cites Figures 4A and 4B as supplying element (a) of Applicants' claims – simultaneously etching the bottoms of recessed features while depositing metal from a source on the sidewalls. Deposition of the diffusion barrier 61 is cited as supplying element (b) of Applicants' claims.

Figure 4A of Hashim shows a SiN capping layer between copper line 57a and the overlying ILD layer 69. A via 59' etched in ILD 59, which is above copper line 57a. A layer of copper oxide 57a' is formed on copper line 57a. Figure 4B shows sputter-etching the silicon nitride layer 55 and copper oxide 57a' via an argon plasma. The operation is described in Hashim as

"As the silicon nitride layer is sputter-etched, silicon nitride layer material is redistributed along the sidewalls of the via 59a', forming a redistributed nitride layer 55' thereon. Subsequently, when the copper oxide later 57a' is sputter-etched, copper oxide layer material, including copper atoms 57a'', redistributes along the sidewalls of the via 59' on top of the redistributed nitride layer 55'." (col. 8, lines 56-67).

Thus, while SiN material is redistributed from the bottom of the via to the sidewalls while the bottom of the via is etched, Applicants submit that this operation does not involve "sputtering metal from a target," to deposit the first portion of the barrier while simultaneously etching the bottom of the via as required by the claims.

Hashim describes several other embodiments; however none of these disclose both operations (a) and (b). The embodiment depicted in Figs. 3A-3C for example, shows deposition of a single barrier layer 51, which is also sputter-etched to redistribute it along the sidewalls. However, there is no second portion of a barrier layer deposited on the bottoms of the feature – rather the via is filled with copper. Similarly, Figs. 5A-5C also show redistribution of barrier layer 71, but without any subsequent deposition of a second portion of the barrier layer.

With regard to the rejection over Golparaja, Applicants submit that there is no teaching or suggestion that the bottom of the via is simultaneously etch while a barrier layer is deposited as required by operation (a). Moreover, there is no teaching or suggestion that forming a second portion of a diffusion barrier in Golparaja. Layer 228 – cited by the Examiner as the second portion of a diffusion barrier – is a copper seed layer (col. 13, lines 28-31). Applicants were unable to find any mention of a second portion of a diffusion barrier in Golparaja. Applicants note that the Final Office Action did not address these arguments (submitted in the previous Amendment) and respectfully request consideration of these arguments.

In view of the above, it is respectfully submitted that claim 1, and all of its dependent claims, are not anticipated by either Golparaja or Hashim.

*Rejections Under 35 U.S.C § 103*

Claims 3-5, 9-15, 20 and 23 are rejected under 35 U.S.C 103(a) as being unpatentable over Golparaja. Claims 3-5, 9-15, 18-20 and 23 are rejected under 35 U.S.C 103(a) as being unpatentable over Hashim.

As described above, Applicants method includes the steps of (a) etching the bottoms of recessed features on a surface of the substrate to clean at least part of an underlying metal while simultaneously depositing a first portion of a diffusion barrier on at least sidewalls of recessed features; wherein depositing a first portion of a diffusion barrier comprises sputtering metal from a target and (b) depositing a second portion of the diffusion barrier, which covers at least the bottoms of the recessed features. The methods of Applicants' invention have various advantages. For example, in some embodiments, the methods of Applicants' invention allow little or no barrier to be deposited on the feature bottom early in the process, which may be desirable to reduce etch time and increase throughput, while still resulting in barrier material at the bottom of the feature (see, e.g., page 5, lines 7-10).

With regard to Golparaja, Applicants submit that there is no teaching or suggestion of recited elements of operations (a) and (b) of claim 1, as discussed above with respect to the 35 U.S.C § 102 rejection.

With regard to Hashim, the Examiner contends that Hashim lacks anticipation only in not teaching the various features of the dependent claims, including etch-to-deposition ratios, etc. Applicants submit that claim 1, as amended, as well as the various features of these dependent claims are not taught or suggested by Hashim. As indicated above, Hashim does not teach or suggest depositing a first portion of barrier material by sputtering metal from a target. This distinction is important because the methods of Hashim shown in Figs 4A-4B require depositing barrier material at the bottom of the via early in the process, thereby increasing process time. In other embodiments of Hashim, such as those shown in Figs. 3A-3C and 5A-C, there is no barrier material at the bottom of the feature.

In view of the above, it is respectfully submitted that claim 1, and all of its dependent claims, are patentable over Golparaja and Hashim. Withdrawal of all rejections is respectfully requested.

Conclusion:

In light of the foregoing amendments and remarks, Applicants respectfully submit that all pending claims are now in condition for allowance. Thus, Applicants respectfully request a Notice of Allowance from the Examiner. Should any unresolved issues remain, the Examiner is encouraged to contact the undersigned at the telephone number provided below. No fees appear to be necessary for this Amendment. However, if the Commissioner determines that any fee is due, such fee may be charged to deposit account No. 500388 (Order No. NOVLP024X2).

Respectfully submitted,  
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